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PORTAGE LAKE, HOUGHTON COUNTY, MICHIGAN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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REPORT

ON

PORTAGE LAKE

HOUGHTON COUNTY

MICHIGAN

EPA REGION V

WORKING PAPER No. 206

WITH THE COOPERATION OF THE

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

AND THE

MICHIGAN NATIONAL GUARD

FEBRUARY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Michigan Department of Natural Resources for professional involvement and to the Michigan National Guard for conducting the tributary sampling phase of the Survey.

A. Gene Gazlay, former Director, and David H. Jenkins, Acting Director, Michigan Department of Natural Resources; and Carlos Fetterolf, Chief Environmental Scientist, and Dennis Tierney, Aquatic Biologist, Bureau of Water Management, Department of Natural Resources, provided invaluable lake documentation and counsel during the course of the Survey. John Vogt, Chief of the Bureau of Environmental Health, Michigan Department of Public Health, and his staff were most helpful in identfying point sources and soliciting municipal participation in the Survey.

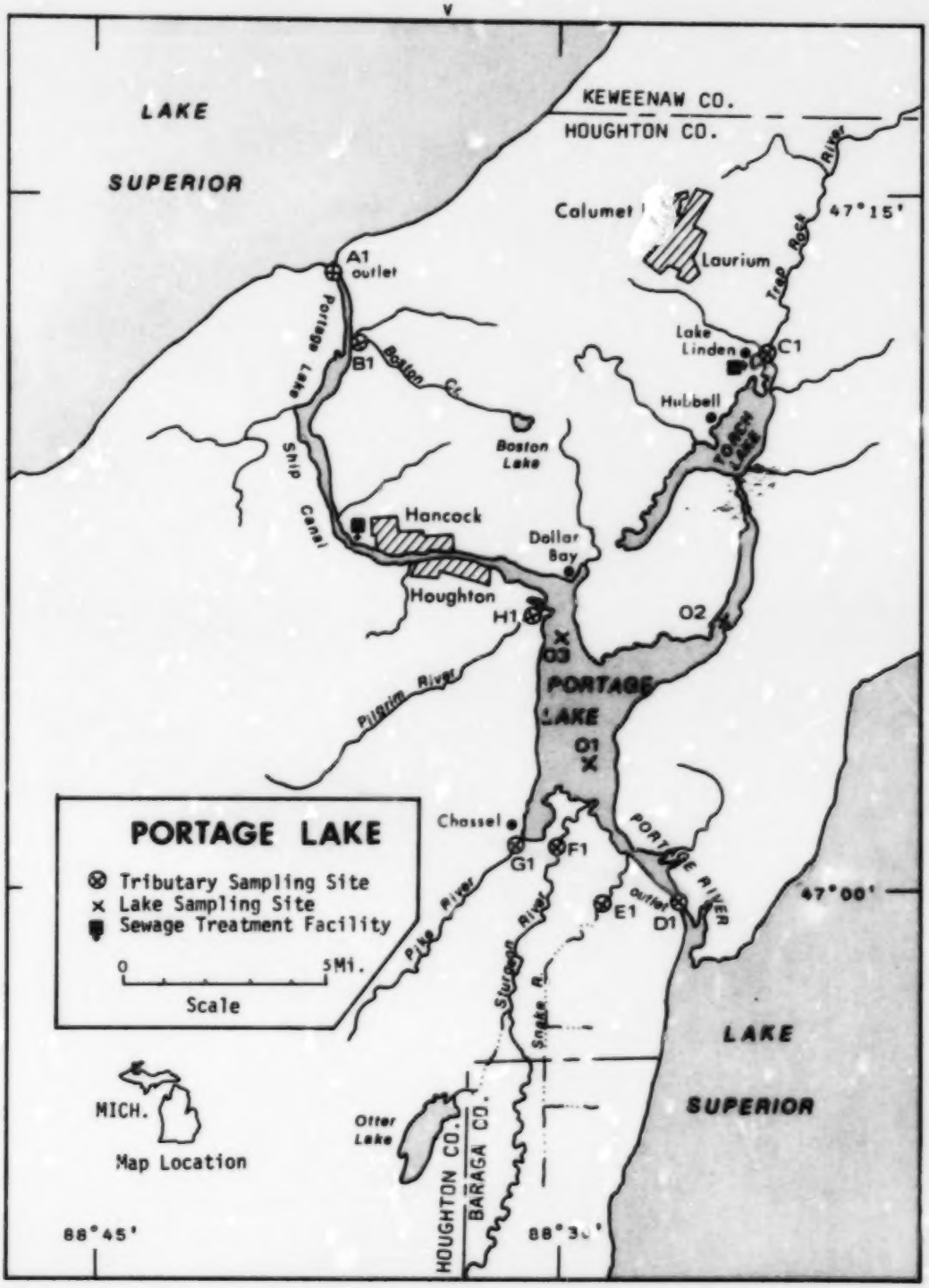
Major General Clarence A. Schnipke (Retired), then the Adjutant General of Michigan, and Project Officer Colonel Albert W. Lesky, who directed the volunteer efforts of the Michigan National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MICHIGAN

LAKE NAME	COUNTY
Allegan Res.	Allegan
Barton	Kalamazoo
Belleville	Wayne
Betsie	Benzie
Brighton	Livingston
Caro Res.	Tuscola
Charlevoix	Charlevoix
Chemung	Livingston
Constantine Res.	St. Joseph
Crystal	Montcalm
Deer	Marquette
Ford	Washtenaw
Fremont	Newago
Higgins	Roscommon
Holloway Res.	Genesee, Lapeer
Houghton	Roscommon
Jordon	Ionia, Barry
Kent	Oakland
Long	St. Joseph
Macatawa	Ottawa
Manistee	Manistee
Mona	Muskegon
Muskegon	Muskegon
Pentwater	Oceana
Pere Marquette	Mason
Portage	Houghton
Randall	Branch
Rogers Pond	Mecosta
Ross	Gladwin
St. Louis Res.	Gratiot
Sanford	Midland
Strawberry	Livingston
Thompson	Livingston
Thornapple	Barry
Union	Branch
White	Muskegon


LAKE
SUPERIOR
KEWEENAW CO.
HOUGHTON CO.
Calumet
Laurium
47°15'
A1
outlet
Portage Lake
B1
Boston Cr.
Boston Lake
Ship Canal
Hancock
Lake Linden
C1
Hubbell
Torch Lake
Torch River
Dollar Bay
Houghton
H1
O2
O3
PORTAGE LAKE
O1
Pilgrim River
Chassel
G1
F1
Pike River
Sturgeon River
Sturgeon R.
Portage River
outlet
E1
D1
47°00'
LAKE
SUPERIOR
PORTAGE LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0
5Mi.
Scale
MICH.
Map Location
Otter Lake
HOUGHTON CO.
BARAGA CO.
88°45'
88°30'

PORTAGE LAKE

STORET NO. 2669

I. CONCLUSIONS

A. Trophic Condition:

Portage Lake was sampled only two times. On the basis of these somewhat limited data, it appears that the lake is mesotrophic. Using comparable sampling times, of the 35 Michigan lakes on which sampling was completed, only four had less mean total and dissolved phosphorus, only two had less mean inorganic nitrogen, five had less mean chlorophyll a, and six had greater Secchi disc transparency*.

Survey limnologists described the overall appearance of the lake as "good".

B. Rate-Limiting Nutrient:

The algal assay sample was lost in shipment; however, the lake date indicate phosphorus limitation in June and September.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Portage Lake received a total phosphorus load at a rate just in excess of the rate proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 12). Now, Vollenweider's model may not apply to water bodies with short hydraulic retention times, and the hydraulic retention time of Portage Lake

* See Appendix A.

is not known. However, the maximum depth of the lake is 59 feet; and, if it is assumed that the mean depth is about one-third of the maximum depth (20 feet), the mean hydraulic retention time would be 93 days. If the assumed mean depth is reasonable, it is likely that Vollenweider's model is applicable. It is calculated that the communities of Houghton-Hancock and Lake Linden contributed 27% of the total phosphorus load to Portage Lake during the sampling year. Removal of 80% of the phosphorus at these two point sources would reduce the loading rate to 0.75 $g/m^2/yr$, a mesotrophic loading rate, and would protect the existing good water quality of Portage Lake as well as provide additional protection for downstream Lake Superior.

Reportedly (Courchaine, 1972), Lake Linden wastewater treatment facilities were scheduled for construction.

2. Non-point sources (see page 12)--The phosphorus exports of the sampled tributaries to Portage Lake were somewhat high as compared to the export of unimpacted Gold Mine Creek tributary to nearby Deer Lake* (33 $lbs/mi^2/yr$).

There are no known point sources impacting these streams, and it appears that either the geological characteristics of the drainage, agricultural practices, or both are the cause of the relatively high export rates.

* Working Paper No. 192.

In all, it is estimated that non-point sources, including precipitation, contributed nearly 73% of the total phosphorus load to Portage Lake during the sampling year.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 10,970 acres.
2. Mean depth: unkncwn.
3. Maximum depth: 59 feet.
4. Volume unknown.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Sturgeon River	728.0 mi^2	825.1 cfs
Pike River	17.4 mi^2	20.7 cfs
Pilgrim River	22.8 mi^2	27.1 cfs
Minor tributaries & immediate drainage -	205.7 mi^2	253.1 cfs
Totals	973.9 mi^2	1,126.0 cfs

2. Outlet -

Portage River - Portage Lake ship canal	991.0 mi^2**	1,126.0 cfs

C. Precipitation***:

1. Year of sampling: 31.9 inches.
2. Mean annual: 28.7 inches.

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† Fetterolf, 1973.
* Drainage areas are accurate within ±5%; mean daily flows for 74% of the sampling sites are accurate within ±25% and the remaining sites up to ±40%; and mean monthly flows, normalized mean monthly flows, and mean annual flows are slightly more accurate than mean daily flows.
** Includes area of lake.
*** See Working Paper No. 1, "Survey Methods, 1972".

III. LAKE WATER QUALITY SUMMARY

Portage Lake was sampled two times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from two or more depths at each station (see map, page v). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the second visit, a single five-gallon depth-integrated sample was composited for algal assays (this sample was lost in shipment). Also each time, depth-integrated samples were collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 43 feet at station 1, 20 feet at station 2, and 20 feet at station 3.

The results obtained are presented in full in Appendix C, and the data for the September sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters in June, refer to Appendix C.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (09/10/72)		
Temperature (Cent.)	15.6	17.2	17.4	17.6
Dissolved oxygen (mg/l)	6.8	8.8	9.0	9.4
Conductivity (μmhos)	120	149	149	167
pH (units)	6.4	6.8	6.8	7.0
Alkalinity (mg/l)	40	45	44	53
Total P (mg/l)	0.009	0.012	0.012	0.018
Dissolved P (mg/)	0.006	0.007	0.007	0.011
NO_2 + NO_3 (mg/l)	0.030	0.085	0.090	0.160
Ammonia (mg/l)	0.050	0.063	0.060	0.080
		ALL VALUES		
Secchi disc (inches)	68	91	92	108

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/25/72	1. Cryptomonas	535
	2. Asterionella	499
	3. Scenedesmus	383
	4. Fragilaria	369
	5. Dinobryon	333
	Other genera	123
	Total	2,242
09/10/72	1. Dinobryon	752
	2. Microcystis	644
	3. Attheya	484
	4. Cryptomonas	80
	5. Anabaena	72
	Other genera	463
	Total	2,495

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/25/72	01	10.8
	02	5.1
	03	3.6
09/10/72	01	6.3
	02	1.9
	03	0.3

C. Limiting Nutrient Study:

As noted before, the algal assay sample was lost in shipment. However, the lake data indicate phosphorus limitation in June and September (N/P ratios were 15/1 and 21/1, respectively).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Michigan National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were collected. Sampling was begun in October, 1972, and was completed in October, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Michigan District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean concentrations and mean flows. The nutrient loads for the two outlets (A-1 and D-1) were calculated using the mean of the nutrient concentrations in both and the combined mean flow ("D-1", Appendix B).

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the mean concentrations in Boston Creek at station B-1 and the mean ZZ flow.

The operator of the Houghton-Hancock wastewater treatment plant provided monthly effluent samples and corresponding flow data. However, during the sampling year, Lake Linden had no waste treatment plant, and nutrient loads for that source were estimated at 3.5 lbs P and 9.4 lbs N/capita/year.

In this report, it is assumed that all of the nutrients from both sources reached Portage Lake during the sampling year.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Houghton-Hancock	10,887	act. sludge	1.795	Portage Lake
Lake Linden	1,214	untreated	0.121*	Torch Lake

2. Known industrial - None

† Courchaine, 1972; Rydquist, 1973.
* 1970 Census.
** Estimated at 100 gal/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Sturgeon River	55,230	59.1
Pike River	2,280	2.4
Pilgrim River	2,190	2.3
b. Minor tributaries & immediate drainage (non-point load) -	6,480	7.0
c. Known municipal STP's -		
Houghton-Hancock	21,020	22.5
Lake Linden	4,250	4.6
d. Septic tanks* -	310	0.3
e. Known industrial - None	-	-
f. Direct precipitation** -	1,710	1.8
Total	93,470	100.0

2. Outputs -

Lake outlet: Portage River - Portage Lake ship canal	35,470

3. Net annual P accumulation - 58,000 pounds

* Estimate based on 495 lakeshore dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Sturgeon River	1,450,510	63.5
Pike River	58,560	2.6
Pilgrim River	56,340	2.5
b. Minor tributaries & immediate drainage (non-point load) -	537,120	23.5
c. Known municipal -		
Houghton-Hancock	52,170	2.3
Lake Linden	11,410	0.5
d. Septic tanks* -	11,630	0.5
e. Known industrial - None	-	-
f. Direct precipitation** -	105,680	4.6
Total	2,283,420	100.0

2. Outputs -

Lake outlet: Portage River - Portage ship canal	1,791,070

3. Net annual N accumulation - 492,350 pounds

* Estimate based on 495 lakeshore dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs $P/mi^2/yr$	lbs $N/mi^2/yr$
Sturgeon River	76	1,992
Pike River	131	3,366
Pilgrim River	96	2,471

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with very short hydraulic retention times.

Units	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
lbs/acre/yr	8.5	5.3	208.2	44.9
grams/m^2/yr	0.96	0.59	23.3	5.0

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on surface area and mean outflow of Portage Lake:

"Dangerous" (eutrophic rate)	0.92
"Permissible" (oligotrophic rate)	0.46

V. LITERATURE REVIEWED

Courchaine, Cletus, 1972. Treatment plant questionnaire (Lake Linden sewage facilities). MI Dept. Publ. Health, Escanaba.

Fetterolf, Carlos, 1972. Personal communication (lake morphometry). MI Dept. of Nat. Resources, Lansing.

Rydquist, Jack W., 1973. Treatment plant questionnaire (Houghton-Hancock STP). MI Dept. Nat. Resources, Escanaba.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES			ALL VALUES		
		MEAN TOTAL P	MEAN DISS P	MEAN INORG N	SEC- MEAN SEC	MEAN CHLORA	15- MIN UO
2640	HOLLOWAY RESERVOIR	0.062	0.043	1.461	439.375	10.678	9.200
2641	CARO RESERVOIR	0.117	0.022	3.035	473.000	11.967	9.500
2642	BOARDMAN HYDRO POND	0.006	0.005	0.358	363.500	1.267	6.600
2643	ALLEGAN LAKE	0.123	0.057	1.168	470.222	20.311	12.600
2646	BARTON LAKE	0.121	0.086	1.489	456.167	27.800	14.850
2649	BELLEVILLE LAKE	0.118	0.048	1.420	469.250	28.262	8.200
2650	BETSIE LAKE	0.025	0.008	0.273	461.667	4.567	7.400
2653	BRIGHTON LAKE	0.109	0.073	1.015	456.000	44.233	7.500
2657	LAKE CHARLEVOIX	0.007	0.006	0.230	351.250	3.000	9.240
2658	LAKE CHEMUNG	0.044	0.014	0.132	404.333	13.483	14.800
2661	CONSTANTINE RESERVOIR	0.027	0.008	0.910	456.167	39.317	7.500
2669	FORD LAKE	0.105	0.058	1.536	456.167	14.733	14.000
2671	FREMONT LAKE	0.372	0.342	1.406	441.667	28.500	14.800
2680	JORDAN LAKE	0.188	0.144	1.998	427.667	20.517	14.900
2683	KENT LAKE	0.040	0.015	0.417	455.000	33.944	13.000
2688	LAKE MACATAWA	0.197	0.120	2.358	477.600	25.600	12.200
2689	MANISTEE LAKE	0.018	0.010	0.304	451.333	6.317	11.300
2699	MUSKEGON LAKE	0.087	0.043	0.489	436.444	9.511	14.800
2705	PENTWATER LAKE	0.027	0.017	0.498	438.667	16.083	14.800
2721	RANDALL LAKE	0.246	0.183	0.810	497.333	27.217	8.020
2722	ROGERS POND	0.026	0.015	0.183	435.500	0.133	9.600
2723	RUSS RESERVOIR	0.034	0.021	0.460	469.333	10.383	8.200
2724	SANFORD LAKE	0.016	0.008	0.387	458.750	13.791	8.300
2733	THORNAPPLE LAKE	0.042	0.032	1.737	442.833	14.050	10.800
2735	UNION LAKE	0.083	0.064	1.252	455.500	15.067	8.200
2738	WHITE LAKE	0.027	0.019	0.367	417.778	7.211	13.400
2741	MONA LAKE	0.387	0.241	0.963	451.667	27.783	14.100
2742	LONG LAKE	0.163	0.148	0.749	418.400	10.867	13.600

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: SDD-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 1S-MIN DO
2693	ST LOUIS RESERVOIR	0.134	0.093	1.227	462.667	5.583	8.420
2694	CHYSTAL LAKE	0.009	0.006	0.164	380.000	2.986	13.080
2695	HIGGINS LAKE	0.007	0.005	0.058	268.500	1.043	9.400
2696	HOUGHTON LAKE	0.018	0.008	0.136	420.833	9.217	8.200
2697	THOMPSON LAKE	0.043	0.029	0.436	407.889	11.967	14.800
2698	PERE MARQUETTE LAKE	0.032	0.024	0.346	448.667	11.833	8.600
2699	STRAWBERRY LAKE	0.069	0.050	0.567	419.800	11.117	13.600

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: SEC-MEAN SEC	ALL VALUES: MEAN CHLOPA	ALL VALUES: 15-MIN DO	INDEX NO
2640	HALLOWAY RESERVOIR	46 (16)	43 (15)	17 (6)	57 (20)	60 (21)	63 (22)	286
2641	CARO RESERVOIR	29 (10)	54 (19)	0 (0)	3 (1)	49 (17)	54 (19)	189
2642	BOARDMAN HYDRO POND	97 (34)	97 (34)	69 (24)	91 (32)	94 (33)	97 (34)	545
2603	ALLEGAN LAKE	20 (7)	31 (11)	31 (11)	6 (2)	29 (10)	40 (14)	157
2606	BANTON LAKE	23 (8)	20 (7)	14 (5)	29 (9)	14 (5)	3 (1)	103
2609	BELLEVILLE LAKE	26 (9)	37 (13)	20 (7)	11 (4)	11 (4)	79 (26)	184
2610	BETSIE LAKE	77 (27)	77 (27)	80 (28)	17 (6)	86 (30)	94 (33)	431
2613	BRIGHTON LAKE	31 (11)	23 (8)	34 (12)	34 (12)	0 (0)	90 (31)	212
2617	LAKE CHARLEVOIX	91 (32)	91 (32)	83 (29)	94 (33)	89 (31)	60 (21)	508
2618	LAKE CHEMUNG	49 (17)	71 (25)	94 (33)	86 (30)	46 (16)	11 (2)	357
2621	CONSTANTINE RESERVOIR	71 (25)	83 (29)	40 (14)	29 (9)	3 (1)	90 (31)	316
2629	FORD LAKE	34 (12)	29 (10)	11 (4)	29 (9)	37 (13)	23 (8)	163
2631	FREMONT LAKE	0 (0)	0 (0)	23 (8)	54 (19)	9 (3)	11 (2)	97
2640	JORDAN LAKE	11 (4)	11 (4)	6 (2)	69 (24)	26 (9)	0 (0)	123
2643	KENT LAKE	57 (20)	69 (24)	63 (22)	40 (14)	6 (2)	36 (12)	271
2648	LAKE MACATAWA	9 (3)	14 (5)	3 (1)	0 (0)	23 (8)	43 (15)	92
2649	MANISTEE LAKE	80 (28)	74 (26)	77 (27)	46 (16)	80 (28)	46 (16)	403
2659	MUSKEGON LAKE	37 (13)	40 (14)	54 (19)	60 (21)	69 (24)	11 (2)	271
2665	PENTWATER LAKE	69 (24)	63 (22)	51 (18)	66 (23)	31 (11)	11 (2)	291
2671	RANDALL LAKE	6 (2)	6 (2)	43 (15)	23 (8)	20 (7)	86 (30)	184
2672	ROGERS POND	74 (26)	66 (23)	86 (30)	63 (22)	77 (27)	51 (18)	417
2673	RUSS RESERVOIR	60 (21)	57 (20)	57 (20)	9 (3)	63 (22)	74 (26)	320
2674	SANFORD LAKE	86 (30)	80 (28)	74 (26)	20 (7)	43 (15)	71 (25)	374
2683	THORNAPPLE LAKE	54 (19)	46 (16)	9 (3)	51 (18)	40 (14)	49 (17)	249
2685	UNION LAKE	40 (14)	26 (9)	26 (9)	37 (13)	34 (12)	79 (26)	242
2688	WHITE LAKE	66 (23)	60 (21)	66 (23)	80 (28)	74 (26)	31 (11)	377
2691	MONA LAKE	3 (1)	3 (1)	37 (13)	43 (15)	17 (6)	20 (7)	123
2692	LONG LAKE	14 (5)	9 (3)	46 (16)	77 (27)	66 (23)	27 (9)	239

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500- MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15- MIN DO	INDEX NO
2693	ST LOUIS RESERVOIR	17 (6)	17 (6)	29 (10)	14 (5)	83 (29)	69 (24)	229
2694	CRYSTAL LAKE	89 (31)	89 (31)	89 (31)	89 (31)	91 (32)	36 (12)	483
2695	HIGGINS LAKE	94 (33)	94 (33)	97 (34)	97 (34)	97 (34)	57 (20)	536
2696	HOUGHTON LAKE	83 (29)	86 (30)	91 (32)	71 (25)	71 (25)	79 (26)	481
2697	THOMPSON LAKE	51 (18)	49 (17)	60 (21)	83 (29)	51 (18)	11 (2)	305
2698	PERE MARQUETTE LAKE	63 (22)	51 (18)	71 (25)	49 (17)	54 (19)	66 (23)	354
2699	STRAWBERRY LAKE	43 (15)	34 (12)	49 (17)	74 (26)	57 (20)	27 (9)	284

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2669 PORTAGE LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 991.00

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2669D1	991.00	567.75	516.68	906.20	3634.80	2313.60	1211.60	822.09	591.78	602.80	754.00	888.18	702.93	1126.02
2669F1	728.00	416.00	379.00	664.00	2670.00	1690.00	888.00	602.00	434.00	442.00	553.00	652.00	512.00	825.13
2669G1	17.40	6.64	5.45	13.40	77.00	49.90	23.60	13.20	7.80	11.20	13.10	16.10	10.60	20.67
2669H1	22.80	8.70	7.14	17.60	101.00	65.30	30.90	17.30	10.20	14.70	17.20	21.10	13.90	27.09
2669ZZ	223.00	128.00	116.00	204.00	817.00	520.00	272.00	185.00	133.00	135.00	169.00	200.00	158.00	253.08

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 991.00
SUM OF SUB-DRAINAGE AREAS = 991.20
TOTAL FLOW IN = 13511.99
TOTAL FLOW OUT = 13512.40

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2669D1	10	72	1210.00	29	637.00				
	11	72	1590.00						
	12	72	687.00	3	750.00				
	1	73	753.00						
	2	73	636.00	3	694.00				
	3	73	3570.00	4	980.00				
	4	73	2630.00	7	2650.00	28	1580.00		
	5	73	3440.00	6	4770.00	19	2240.00		
	6	73	821.00	2	1070.00				
	7	73	761.00	15	677.00				
	8	73	757.00	23	744.00				
	9	73	639.00	10	646.00				
	10	73	523.00	7	509.00				
2669F1	10	72	887.00	29	466.00				
	11	72	1170.00						
	12	72	504.00	3	551.00				
	1	73	553.00						
	2	73	467.00	3	509.00				
	3	73	2620.00	4	719.00				
	4	73	1930.00	28	1160.00				
	5	73	2520.00	6	3500.00	19	1650.00		
	6	73	602.00	2	786.00				
	7	73	559.00	15	497.00				
	8	73	556.00	23	546.00				
	9	73	469.00	10	474.00				
	10	73	384.00	7	374.00				

20

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2669 PORTAGE LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2669G1	10	72	28.00	29	17.00				
	11	72	32.00						
	12	72	10.00	3	13.00				
	1	73	12.00						
	2	73	9.00	3	12.00				
	3	73	74.00	4	7.00				
	4	73	66.00	7	57.00	28	32.00		
	5	73	81.00	6	140.00	19	42.00		
	6	73	12.00	2	14.00				
	7	73	8.00	15	5.00				
	8	73	11.00	23	13.00				
	9	73	9.00	10	6.00				
	10	73	6.00	7	7.00				
2669H1	10	72	36.00	29	22.00				
	11	72	42.00						
	12	72	13.00	3	17.00				
	1	73	16.00						
	2	73	11.00	3	16.00				
	3	73	98.00	4	9.00				
	4	73	86.00	7	75.00	28	42.00		
	5	73	106.00	19	55.00				
	6	73	17.00	2	19.00				
	7	73	11.00	15	7.00				
	8	73	14.00	23	17.00				
	9	73	12.00	10	8.00				
	10	73	8.00	7	9.00				
2669Z2	10	72	272.00						
	11	72	358.00						
	12	72	155.00						
	1	73	169.00						
	2	73	143.00						
	3	73	803.00						
	4	73	592.00						
	5	73	774.00						
	6	73	185.00						
	7	73	171.00						
	8	73	170.00						
	9	73	144.00						
	10	73	118.00						

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/02/04

266901
47 03 00.0 088 29 30.0
PORTAGE LAKE
26 MICHIGAN

11EPALES 2111202
4 0047 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/25	14	05 0000	16.6	9.4	88	95	7.60	34	0.140	0.010K	0.015	0.010
	14	05 0015	16.0	9.7		90	7.60	32	0.150	0.020	0.017	0.010
	14	05 0025	15.0	9.3		95	7.50	32	0.150	0.030	0.015	0.012
72/09/10	13	50 0000			108		6.60	40	0.100	0.060	0.012	0.007
	13	50 0004	17.4	8.8		125	6.60	44	0.090	0.060	0.010	0.006
	13	50 0015	17.4	8.7		155	6.70	44	0.090	0.060	0.010	0.006
	13	50 0022	17.3	8.7		165	6.40	44	0.100	0.080	0.009	0.006
	13	50 0029	17.3	8.9		167	6.70	44	0.090	0.050	0.010	0.006
	13	50 0036	17.3	9.2		167	6.70	47	0.160	0.060	0.011	0.008
	13	50 0043	15.6	6.6		164	6.50	50	0.160	0.060	0.013	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/25	14	05 0000	10.8J
72/09/10	13	50 0000	6.3J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

266902
47 06 00.0 088 25 00.0
PORTAGE LAKE
26 MICHIGAN

11EPALES
4

2111202
0020 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/25	14 45	0000	17.0	9.8	68	100	7.70	35	0.150	0.020	0.030	0.016
	14 45	0020	14.0	8.4		100	7.40	35	0.160	0.020	0.017	0.010
72/09/10	13 05	0000			96		6.80	44	0.040	0.080	0.018	0.011
	13 05	0004	17.6	9.2		148	7.00	43	0.030	0.060	0.013	0.007
	13 05	0015	17.5	9.0		149	6.90	43	0.030	0.050	0.012	0.006
	13 05	0019	17.5	9.1		149	7.00	45	0.030	0.060	0.013	0.007

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/25	14 45	0000	5.1J
72/09/10	13 05	0000	1.4J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

266903
47 05 00.0 088 30 00.0
PORTAGE LAKE
26061 MICHIGAN

11EPALES
6

2111202
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/25	15 20	0000	16.5	10.3	75	95	7.80	37	0.160	0.030	0.028	0.018
	15 20	0020	14.5	8.8		95	7.50	37	0.180	0.070	0.017	0.011
72/09/10	13 30	0000			108		6.90	53	0.090	0.080	0.015	0.009
	13 30	0004	17.4	9.3		120	7.00	45	0.090	0.060	0.014	0.008
	13 30	0011	17.4	9.4		130	7.00	44	0.090	0.060	0.011	0.008

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/25	15 20	0000	3.6J
72/09/10	13 30	0000	0.3J

J VALUE KNOWN TO BE IN ERROR

APPENDIX D

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/02/04

2669A1 LS2669A1
47 13 30.0 088 37 30.0
PORTAG LAKE SHIP CANAL
26 15 HOUGHTON
0/PORTAGE LAKE
BANK E SIDE OF CANAL 6.5 MI N HANCOCK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	09 30		0.250	0.200	0.056	0.008	0.010
72/12/03	09 15		0.280	0.250	0.038	0.006	0.012
73/01/07	09 15		0.310	2.300	0.065	0.005K	0.007
73/02/03	09 00		0.290	0.180	0.056	0.020	0.020
73/03/04	09 45		0.260	0.115	0.012	0.005K	0.005K
73/04/07	10 00		0.240	2.100	0.068	0.006	0.020
73/04/28	09 30		0.270	0.270	0.015	0.005K	0.005K
73/05/06	09 35		0.290	0.380	0.040	0.010	0.025
73/05/19	15 15		0.260	0.360	0.020	0.005K	0.010
73/06/02	09 05		0.066	0.520	0.054	0.008	0.015
73/07/15	08 32		0.250	0.180	0.030	0.005K	0.005K
73/08/23	15 45		0.260	0.230	0.013	0.009	
73/09/10	14 30		0.072	0.160	0.066	0.005K	0.010
73/10/07	08 10		0.230	0.250	0.060		0.005

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

266981 LS266981
47 12 00.0 088 37 00.0
BOSTON CREEK
26 15 HOUGHTON
1/PORTAGE LAKE
ST HWY 203 HROG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	09 45		0.550	0.150	0.031	0.005K	0.005K
72/12/03	09 25		0.260	2.200	0.054	0.005K	0.008
73/02/03	09 20		0.294	0.540	0.075	0.008	0.010
73/03/04	10 10		0.320	0.560	0.091	0.005K	0.010
73/04/07	10 20		0.170	0.480	0.028	0.005K	0.010
73/04/28	09 30		0.168	1.260	0.066	0.005K	0.010
73/05/06	10 15		0.680	0.460	0.022	0.005K	0.030
73/05/19	14 28		0.132	1.050	0.061	0.005K	0.020
73/06/02	09 15		0.270	1.490	0.066	0.005K	0.010
73/07/15	08 37		0.650	0.520	0.048	0.005K	0.010
73/08/23	15 50		0.200	0.340	0.032	0.006	0.015
73/09/10	14 45		1.500	0.780	0.077	0.005K	0.010
73/10/07	09 15		0.190	1.400	0.080	0.014	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

266YC1 LS266YC1
47 12 00.0 088 24 00.0
TRAP ROCK RIVER
26 7.5 LOURIUM
T/PORTAGE LAKE
BOOTJACK RD BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	12 45		0.230	0.200	0.074	0.013	0.022
72/12/03	12 15		0.340	0.400	0.021	0.018	0.033
73/01/07	11 15		0.349	0.930	0.105	0.021	0.032
73/02/03	10 00		0.350	0.340	0.044	0.016	0.020
73/03/04	09 00		0.430	0.420	0.044	0.015	0.035
73/04/07	10 50		0.140	0.460	0.023	0.008	0.025
73/04/28	10 15		0.660	0.780	0.040	0.022	0.035
73/05/06	11 15		0.139	1.470	0.040	0.011	0.042
73/05/19	13 30		0.390	1.100	0.034	0.012	0.030
73/06/02	08 30		0.320	0.450	0.069	0.015	0.025
73/07/15	09 05		0.294	0.340	0.035	0.005K	0.025
73/08/23	18 45		0.138	1.540	0.039	0.019	0.035
73/09/10	17 45		0.330	0.290	0.039	0.052	0.095
73/10/07	11 30		0.230	0.420	0.049	0.033	0.052

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

2669U1 LS2669U1
47 00 00.0 088 26 30.0
PORTAGE RIVER
26 7.5 POPE MILLS
U/PORTAGE LAKE
FROM MESSNER DOCK NW OF PORTAGE ENTRY
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	11 10		0.220	0.500	0.088	0.005K	0.014
72/12/03	10 50		0.189	0.620	0.042	0.008	0.014
73/01/07	10 01		0.260	1.100	0.160	0.017	0.018
73/02/03	09 35		0.280	1.300	0.075	0.007	0.010
73/03/04	09 07		0.231	0.270	0.024	0.008	0.015
73/04/07	10 22		0.200	0.270	0.016	0.005K	0.010
73/04/28	10 20		0.154	1.050	0.048	0.005K	0.015
73/05/06	10 20		0.500	0.500	0.014	0.006	0.030
73/05/19	15 36		0.091	0.440	0.025	0.005K	0.030
73/06/02	10 23		0.198	0.350	0.050	0.005K	0.005K
73/07/15	11 15		0.069	0.580	0.040	0.005K	0.015
73/08/23	16 20		0.470	0.540	0.031	0.029	0.040
73/09/10	16 15		0.350	0.250	0.070	0.012	0.020
73/10/07	10 00		0.399	0.380	0.075	0.042	0.050

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

26069E1 LS2069E1
47 00 00.0 088 29 00.0
SNAKE RIVER
26 15 KEWEENAW BAY
T/PORTAGE LAKE
US 41 XING
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	10 48		0.247	1.750	0.360	0.026	0.189
72/12/03	11 00		0.198	1.470	0.231	0.075	0.132
73/02/03	09 48		0.198	0.660	0.250	0.072	0.110
73/03/04	09 19		0.250	2.200	0.336	0.084	0.150
73/04/07	10 09		0.056	0.830	0.037	0.016	0.035
73/04/28	10 28		0.060	1.100	0.040	0.026	0.060
73/05/06	09 35		0.280	0.780	0.022	0.015	0.035
73/05/19	15 46		0.044	0.960	0.092	0.018	0.040
73/06/02	10 43		0.034	0.520	0.050	0.005K	0.020
73/07/15	11 00		0.154	1.260	0.092	0.142	0.220
73/08/23	16 35		0.052	0.420	0.045	0.017	0.035
73/09/10	15 50		0.046	1.400	0.060	0.016	
73/10/07	10 15		0.021	0.550	0.078	0.011	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

2669F1 LS2669F1
47 01 00.0 088 30 30.0
STURGEON RIVER
26 15 HOUGHTON
T/PORTAGE LAKE
US 41 BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	10 40		0.094	2.200	0.180	0.007	0.029
72/12/03	11 12		0.084	1.100	0.089	0.011	0.026
73/01/07	10 35		0.126	0.990	0.063	0.007	0.020
73/02/03	10 02		0.147	1.400	0.087	0.017	0.025
73/03/04	09 27		0.154	0.390	0.039	0.014	0.030
73/04/07	10 03		0.096	0.440	0.016	0.016	0.030
73/04/28	10 35		0.069	0.400	0.016	0.007	0.020
73/05/06	10 30		0.300	0.580	0.013	0.010	0.060
73/05/19	15 50		0.052	1.540	0.050	0.008	0.035
73/06/02	10 38		0.050	1.980	0.100	0.036	0.095
73/07/15	10 50		0.026	1.260	0.067	0.013	0.025
73/08/23	16 40		0.028	0.340	0.046	0.006	0.020
73/09/10	15 40		0.180	0.320	0.147	0.012	0.035
73/10/07	10 22		0.010K	0.440	0.038	0.007	0.030

STORET RETRIEVAL DATE 75/02/04

266961 LS266961
47 01 00.0 088 01 30.0
PIKE RIVER
26 15 HOUGHTON
T/PORTAGE LAKE
US 41 BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	10 30		0.277	2.300	0.710	0.005K	0.022
72/12/03	11 18		0.105	0.770	0.027	0.008	0.018
73/01/07	10 50		0.176	0.850	0.072	0.010	0.023
73/02/03	10 17		0.168	1.760	0.110	0.014	0.025
73/03/04	09 40		0.230	1.980	0.098	0.017	0.060
73/04/07	09 56		0.072	0.400	0.019	0.008	0.020
73/04/28	10 39		0.034	0.400	0.016	0.007	0.020
73/05/06	10 36		0.590	1.680	0.056	0.010	0.035
73/05/19	15 55		0.050	1.800	0.044	0.007	0.025
73/06/02	10 54		0.019	0.440	0.031	0.009	0.020
73/07/15	10 45		0.031	0.340	0.027	0.009	0.030
73/08/23	16 45		0.026	1.800	0.140	0.130	0.270
73/09/10	15 30		0.460	0.520	0.176	0.020	0.055
73/10/07	11 00		0.042	2.800	0.140	0.043	0.160

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

2669M1 LS2669M1
47 06 00.0 088 31 00.0
PILGRIM RIVER
26 15 HOUGHTON
T/PORTAGE LAKE
US 41 BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	10 15		0.286	0.700	0.082	0.006	0.015
72/12/03	10 18		0.580	0.720	0.044	0.025	0.035
73/01/07	09 31		0.670	1.100	0.126	0.034	0.046
73/02/03	09 10		0.740		0.240	0.072	0.105
73/03/04	08 45		0.550	0.480	0.072	0.032	0.055
73/04/07	09 46		0.200	0.580	0.016	0.014	0.038
73/04/28	10 03		0.330	1.200	0.058	0.020	0.030
73/05/06	09 23		0.294	0.540	0.015	0.019	0.055
73/05/19	15 14		0.244	0.920	0.044	0.021	0.035
73/06/02	11 25		0.300	1.900	0.066	0.019	0.025
73/07/15	10 30		0.550	0.250	0.023	0.024	0.040
73/08/23	16 55		0.062	0.100K	0.014	0.005K	0.020
73/09/10	15 15		0.040	0.380	0.260	0.033	0.055
73/10/07	10 45		0.063	0.700	0.069	0.012	0.025

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

266950 AS266950 PU12000
47 07 30.0 088 36 00.0
HOUGHTON-HANCOCK
26061 15 HOUGHTON
U/PORTAGE LAKE
PORTAGE LAKE
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/31	08 00								
CP(T)-			0.155	15.000	1.600	3.900	4.700	1.720	1.760
73/02/01	08 00								
73/02/27	00 00								
CP(T)-			0.175	14.700	2.600	3.600	4.000	1.660	1.660
73/02/27	24 00								
73/04/03	08 00								
CP(T)-			0.340	13.200	1.890	2.300	3.700	1.920	2.320
73/04/04	08 00								
73/04/27	08 00								
CP(T)-			1.200	9.900	1.100	2.800	4.000	1.920	1.980
73/04/28	08 00								
73/06/27	08 00								
CP(T)-			1.500	3.900	0.340	2.800	3.300	1.750	1.830
73/06/28	08 00								
73/07/30	08 00								
CP(T)-			0.360	1.200	0.500	2.250	2.415	2.270	1.800
73/07/31	08 00								
73/08/30	00 00								
CP(T)-				5.500			3.700	2.200	2.170
73/08/30	24 00								
73/09/26	00 00								
CP(T)-			0.700	2.900	0.500	2.300	2.600	2.150	1.700
73/09/26	24 00								
73/10/31	00 00								
CP(T)-			2.940	5.300	0.230	1.700	2.300	2.250	1.650
73/10/31	24 00								
73/11/29	00 00								
CP(T)-			0.100	7.500	0.100	2.000	3.300	2.070	1.770
73/11/29	24 00								
73/12/27	00 00								
CP(T)-			0.500	0.400	0.070	2.500	0.400	1.550	1.650
73/12/28	24 00								
74/01/30	08 00								
CP(T)-			0.040	0.700	0.040K	3.520	4.400	1.590	1.530
74/01/31	08 00								

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

266950 AS266950 P012000
47 07 30.0 088 36 00.0
HOUGHTON-HANCOCK
26061 15 HOUGHTON
U/PORTAGE LAKE
PORTAGE LAKE
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/02/28 CP(T)- 74/02/28	00 00 24 00		3.500	5.900	0.140	3.000	6.800	1.400	1.520